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LIQUID CRYSTAL PANEL AND ITS MANUFACTURING METHOD

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[Abstract]

PROBLEM TO BE SOLVED: To solve the problem, in a liquid crystal panel wherein a cell gap is supported by the protrusions formed on a substrate, the ease of generation of a low-temperature bubble and the strength to the pushing pressure of the panel depend on the sizes, shapes and the constitution of the underground of the protrusions and the optimal density of the protrusions is difficult to be found.

SOLUTION: It is effective that the density of the protrusions is controlled by the ratio of the sum total area of the protrusions coming, in contact with a color filter substrate to the display region area and the ratio of the sum total

**area of the upper base of the protrusions which come into contact with the counter substrate to the display region area.**

**[Claim(s)]**

**[Claim 1]      A liquid crystal panel comprising a color filter substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite**  
**5      substrate, the color filter substrate being provided with a transparent electrode and a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in that:**  
**a sum of surface areas of the projections which are contacted with the color filter substrate is 0.0016 or more times greater than surface areas of regions**  
**10      in which the color filter substrate is contacted with the liquid crystal material.**

**[Claim 2]      A liquid crystal panel comprising a color filter substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite**  
**substrate, the color filter substrate being provided with a transparent**  
**15      electrode and a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in that:**  
**a sum of surface areas of the projections which are contacted with the opposite substrate is 0.0015 and less times smaller than surface areas of**

regions in which the opposite substrate is contacted with the liquid crystal material.

[Claim 3] A liquid crystal panel comprising a color filter substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate being provided with a transparent electrode and a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in that:

a sum of surface areas of the projections which are contacted with the color filter substrate is 0.0016 or more times greater than surface areas of regions in which the color filter substrate is contacted with the liquid crystal material, and a sum of surface areas of the projections which are contacted with the opposite substrate is 0.0015 and less times smaller than surface areas of regions in which the opposite substrate is contacted with the liquid crystal material.

[Claim 4] A liquid crystal panel comprising a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate

being provided with a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in that:

a sum of surface areas that the projections are contacted with the color filter  
5 substrate is 0.005 or more times greater than surface areas of regions that the color filter substrate is contacted with the liquid crystal material.

[Claim 5] A liquid crystal panel comprising a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between  
10 the color filter substrate and the opposite substrate, the color filter substrate being provided with a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in that:

a sum of surface areas that the projections are contacted with the opposite  
15 substrate is 0.003 and less times smaller than surface areas of regions that the opposite substrate is contacted with the liquid crystal material.

[Claim 6] A liquid crystal panel comprising a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed

to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate being provided with a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, characterized in

5 that:

a sum of surface areas that the projections are contacted with the color filter substrate is 0.005 or more times greater than surface areas of regions that the color filter substrate is contacted with the liquid crystal material, and a sum of surface areas that the projections are contacted with the opposite

10 substrate is 0.003 and less times smaller than surface areas of regions that the opposite substrate is contacted with the liquid crystal material.

[Claim 7] A method of manufacturing a liquid crystal panel, wherein a plurality of projections are formed on one of a pair of substrates so as to keep a gap between the pair of substrates, the pair of substrates are bonded

15 with the projections being interposed therebetween, and a liquid crystal material is interposed between the pair of substrates, characterized in that:

a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with one of the substrates and surface areas of a region in which the substrate is contacted with the liquid

crystal material is above a desired value.

[Claim 8]      A method of manufacturing a liquid crystal panel, wherein a plurality of projections are formed on one of a pair of substrates so as to keep a gap between the pair of substrates, the pair of substrates are bonded  
5    with the projections being interposed therebetween, and a liquid crystal material is interposed between the pair of substrates, characterized in that:  
  
a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with the other substrate on which the projections are not formed and surface areas of a region in which  
10   the other substrate is contacted with the liquid crystal material is below a desired value.

[Claim 9]      A method of manufacturing a liquid crystal panel, wherein a plurality of projections are formed on one of a pair of substrates so as to keep a gap between the pair of substrates, the pair of substrates are bonded  
15   with the projections being interposed therebetween, and a liquid crystal material is interposed between the pair of substrates, characterized in that:  
  
a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with one of the substrates and surface areas of a region in which the substrate is contacted with the liquid

crystal material is above a desired value, and also a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with the other substrate on which the projections are not formed and surface areas of a region in which the other substrate is  
5 contacted with the liquid crystal material is below a desired value.

[Claim 10] A method according to any of claims 7 to 9, wherein one of the substrates, on which the plurality of projections are formed is the color filter substrate.



**[Title of the Invention]**

**LIQUID CRYSTAL PANEL AND MANUFACTURING MEHTOD THEREOF**

**[Detailed Description of the Invention]**

**[Field of the Invention]**

5           The present invention relates to a liquid crystal panel with projections  
for keeping a cell gap and a manufaturing method thereof.

**[Description of the Prior Art]**

FIG. 5 shows a conventional liquid crystal panel.

A liquid crystal panel is constructed by bonding two substrates, i.e., a  
10 color filter substrate 11 and an opposite substrate 12. Spacers are also  
provided between the two substrates so as to uniformly keep a gap  
therebetween.

As the spacers, spheral beads 51 formed of divinylbenzene-based or  
benzoguanamine-based resin, or silicon oxide-based inorganic spheral beads  
15 51 are scattered on either side of the color filter substrate 11 and the opposite  
substrate 12, and the two substrates are then bonded.

This beads-scattering way is generally applied to most assembly

processes of the liquid crystal panel due to its convenience.

Recently, in accordance with the requirements relating to a progression in display quality of the liquid display panel, the following improvements are requested: (1) leakage of light through the scattered beads  
5 51 and its peripheral region, or randomness of the display quality or deterioration of contrast characteristics because of the light leakage by cohesion of the beads upon scattering, (2) progress in uniformity of the cell gap, (3) deterioration in the uniformity of the cell gap, or scratch on a surface of an alignment layer 3 because of movement of the bead particles 51 when  
10 vibrating the liquid crystal panel, etc.

In order to solve the problems, recently, there is proposed a method using photolithographic technology, etc., in which projections made of resin are formed as the spacers for keeping the cell gap on the color filter substrate so as to be disposed at regular intervals and also have the same  
15 height. Therefore, the bead-scattering operation is omitted in the method, (i.e., the method has a beadless construction). Furthermore, such method is already applied to some products.

**[Problem(s) to be Solved by the Invention]**

However, since the projection 52 formed on the color filter substrate

typically has a large amount of plastic deformation and a small amount of elastic deformation in comparison with the beads 51 formed of resin, there is a problem that a margin of choice for a design of projection formation density is narrowed.

5           In case that a liquid crystal panel having a large projection formation density is exposed to a low temperature of about -30°C, there is a problem that the amount of elastic deformation of the liquid crystal panel can not be match with a thermal shrink of liquid crystal material, thereby generating vacuum bubbles.

10           Meanwhile, in case of a liquid crystal panel having a small projection formation density, that is another problem that, since the projections are apt to be stuck in a resin layer such as a color filter layer, a light shielding layer, etc., which functions as a base portion of the projections, gap non-uniformity is occurred by non-uniform pressure in a manufacturing process, or  
15           unexpected load (pressure) upon using the panel, thereby lowering a strength of the panel.

As shown in FIGs. 2a and 2b, the projection 52 has a circular cone shape or a polypyramid shape of which a peak portion is cut away. Each surface area of an upper surface 53 and a lower surface 54 of the projection

52, and a ratio of the two surface areas may be variously formed in accordance with the resin material to be used or design conditions. Depending on the surface area or the shape of the projection and the construction of the resin layer, the bubble generation at a low temperature or the lowering of the panel strength is differently occurred. In the past, the design of projection formation density was determined by the number of projections, but designing in this way was not a sufficient and effective solution.

An object of the present invention is to obtain an effective solution for designing the projection formation density so as to restrain the bubble generation at a lower temperature, and an effective solution for designing the projection formation density so as to restrain the occurrence of the gap non-uniformity due to the non-uniform pressure in a manufacturing process, or the unexpected load (pressure) upon using the panel.

#### 15 [Means for Solving the Problem]

In order to solve the problems, a method of manufacturing a liquid crystal panel according to the present invention controls surface areas of the projections which are respectively contacted with the color filter substrate and the opposite substrate.

Since the bubble generation problem is caused by deterioration of elastic deformation amount of the panel at a low temperature, it is important to control an upper surface area of the projection, which mainly supports the panel. On the other hand, since the lowering of panel strength is caused by  
5 sticking of the projections into the color filter layer, it is important to control surface areas of surfaces of the projections which is contacted with the color filter substrate.

In other words, if the projections formed on the color filter substrate are uniformly arranged in an indicated range (in which the substrate is  
10 contacted with the liquid crystal material) of the liquid crystal panel, as for the bubble generation, it is preferred that the projection density is designed, regardless of a shape of the projection, an upper surface area and a lower surface area, so that a ratio of a sum of upper surface areas in the indicated region and the surface area of the indicated region is below a desired value.  
15 Further, as for the lowering of the panel strength, it is preferred that the projection density is designed, regardless of a shape of the projection, an upper surface area and a lower surface area, so that a ratio of a sum of lower surface areas in the indicated region and the surface area of the indicated region is above a desired value.

For example, assuming that the surface area of the indicated region is S, the upper surface area and the lower surface area of the projection are s-upper and s-lower, respectively, and the projection density is D (EA/surface area of the indicated region), if the bubble generation can be restricted within an extent that the ratio of the sum ( $= S_1$ ) of upper surface areas of the projections and the surface area S of the indicated region is  $\alpha$  and less, and if the lowering of the panel strength can be also restricted within an extent that the ratio of the sum ( $= S_2$ ) of lower surface areas of the projections and the surface area S of the indicated region is  $\beta$  or more, the following equations can be established:

$S_1/S \leq \alpha$  and  $S_2/S \geq \beta$ , further, since each of  $S_1$  and  $S_2$  can be also expressed as follows:

$S_1 = D \times S \times s\text{-upper}$ ,  $S_2 = D \times S \times s\text{-lower}$ , therefore, it is preferred that the projection density D is set to a following extent:  $\beta/s\text{-lower} \leq D \leq \alpha/s\text{-upper}$ .

Furthermore, in case that the projections are formed on the opposite substrate opposed to the color filter substrate, since the bubble generation and the lowering of the panel strength problems are depended upon the surface area (in this case, the upper surface area of the projection) which is contacted with the color filter substrate, it is preferred that the projection

density D is set to a following extent:  $\beta/s\text{-upper} \leq D \leq \alpha/s\text{-lower}$ .

In addition, in the liquid crystal panel of the present invention, it is possible to set the ratio of the surface area of the indicated range and the surface areas of the projections, which are contacted with the color filter substrate and the opposite substrate, within a desired extent, thereby restricting the bubble generation and the lowering of the panel strength problems.

The value of this ratio is varied depending upon a layer construction of a region of the color filter substrate which is contacted with the projection.

10 In case of the projections formed on the color filter substrate having the transparent electrode, as shown in FIG. 3, it is preferred that the sum of the surface areas of the projections which are color filter substrate 11 is 0.0016 or more times the surface area of the indicated region, and the sum of the surface areas of the projections which are opposite substrate 11 is 0.0015

15 and less times the surface area of the indicated region.

Further, in case of the projections formed on the color filter substrate 11 for IPS mode, in which the transparent electrode is not formed, as shown in FIG. 4, it is preferred that the sum of the surface areas of the projections which are color filter substrate 11 is 0.005 or more times the surface area of

the indicated region, and the sum of the surface areas of the projections which are opposite substrate 11 is 0.003 and less times the surface area of the indicated region.

**[Embodiment of the Invention]**

5           A liquid crystal panel described in claim 1 comprises a color filter substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate is provided with a transparent electrode and a plurality of projections for uniformly keeping a gap between  
10 the color filter substrate and the opposite substrate, and a sum of surface areas of the projections which are contacted with the color filter substrate is 0.0016 or more times surface areas of regions in which the color filter substrate is contacted with the liquid crystal material.

          A liquid crystal panel described in claim 2 comprises a color filter  
15 substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate is provided with a transparent electrode and a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, and a sum of surface



areas of the projections which are contacted with the opposite substrate is 0.0015 and less times surface areas of regions in which the opposite substrate is contacted with the liquid crystal material.

A liquid crystal panel described in claim 3 comprises a color filter substrate, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate is provided with a transparent electrode and a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, and a sum of surface areas of the projections which are contacted with the color filter substrate is 0.0016 or more times surface areas of regions in which the color filter substrate is contacted with the liquid crystal material, and a sum of surface areas of the projections which are contacted with the opposite substrate is 0.0015 and less times surface areas of regions in which the opposite substrate is contacted with the liquid crystal material.

A liquid crystal panel described in claim 1 comprises a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the

color filter substrate is provided with a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, and a sum of surface areas that the projections are contacted with the color filter substrate is 0.005 or more times surface areas of regions that the color filter substrate is contacted with the liquid crystal material.

A liquid crystal panel described in claim 5 comprises a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate is provided with a plurality of projections for uniformly keeping a gap between the color filter substrate and the opposite substrate, and a sum of surface areas that the projections are contacted with the opposite substrate is 0.003 and less times surface areas of regions that the opposite substrate is contacted with the liquid crystal material.

A liquid crystal panel described in claim 6 comprises a color filter substrate on which a transparent electrode is not formed, an opposite substrate opposed to the color filter substrate, and a liquid crystal material interposed between the color filter substrate and the opposite substrate, the color filter substrate is provided with a plurality of projections for uniformly

keeping a gap between the color filter substrate and the opposite substrate,  
and a sum of surface areas that the projections are contacted with the color  
filter substrate is 0.005 or more times surface areas of regions that the color  
filter substrate is contacted with the liquid crystal material, and a sum of  
5 surface areas that the projections are contacted with the opposite substrate  
is 0.003 and less times surface areas of regions that the opposite substrate is  
contacted with the liquid crystal material.

In a method of manufacturing a liquid crystal panel described in claim  
7, a plurality of projections are formed on one of a pair of substrates so as to  
10 keep a gap between the pair of substrates, the pair of substrates are bonded  
with the projections being interposed therebetween, and a liquid crystal  
material is interposed between the pair of substrates, and a density of the  
projections is designed so that a ratio of a sum of surface areas of the  
projections which are contacted with one of the substrates and surface areas  
15 of a region in which the substrate is contacted with the liquid crystal material  
is above a desired value.

In a method of manufacturing a liquid crystal panel described in claim  
8, a plurality of projections are formed on one of a pair of substrates so as to  
keep a gap between the pair of substrates, the pair of substrates are bonded

with the projections being interposed therebetween, and a liquid crystal material is interposed between the pair of substrates, and a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with the other substrate on which the  
5 projections are not formed and surface areas of a region in which the other substrate is contacted with the liquid crystal material is below a desired value.

In a method of manufacturing a liquid crystal panel described in claim 9, a plurality of projections are formed on one of a pair of substrates so as to  
10 keep a gap between the pair of substrates, the pair of substrates are bonded with the projections being interposed therebetween, and a liquid crystal material is interposed between the pair of substrates, and a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with one of the substrates and surface areas  
15 of a region in which the substrate is contacted with the liquid crystal material is above a desired value, and also a density of the projections is designed so that a ratio of a sum of surface areas of the projections which are contacted with the other substrate on which the projections are not formed and surface areas of a region in which the other substrate is contacted with the liquid  
20 crystal material is below a desired value.

In a method of manufacturing a liquid crystal panel described in claim 10, one of the substrates, on which the plurality of projections are formed is the color filter substrate.

The present invention will now be described in further detail by  
5 examples.

**(First embodiment)**

By way of assembling a 13.3-inch XGA-TFT liquid crystal panel, a relationship between the bubble generation and the panel strength was investigated with respect to a density of projections 52.

10 First, fourteen sheets of color filter substrates for a 13.3-inch XGATN-liquid crystal panel were prepared for the investigation. As shown in FIG. 3, a transparent electrode is formed on a surface of the color filter substrate.

On each of seven sheets a1, b1, c1, d1, e1, f1, g1 out of the fourteen sheets of color filter substrates 11, acryl-based resistor (as a material E of the  
15 projection) is coated by a spin coater so that a coated film has a thickness of 4.7 $\mu$ m. The coated substrates are pre-baked, exposed through a mask having a desired pattern to ultraviolet rays, developed and then post-baked, thereby forming the projection 52.

At this time, as shown in FIG. 2a, the projection 52 has a circular cone

shape of which a peak portion is cut away. Each surface area of an upper surface 53 and a lower surface 54 of the projection 52 (hereinafter, respectively called as “upper surface area” and “lower surface area”) is shown in table 1. The upper surface is defined as a surface area 55 of a portion, which is located at approximately 90 percent of an entire height of the projection 52, in consideration of the plastic deformation and the elastic deformation of the projection 52 after forming of the panel.

Table 1

Substrate No.	Material of projection	Diameter of upper surface ( $\mu\text{m}$ )	Diameter of lower surface ( $\mu\text{m}$ )	Upper surface ( $\mu\text{m}^2$ )	Lower surface ( $\mu\text{m}^2$ )
a1, b1, c1, d1, e1, f1, g1	E	10	21	78.5	346.2
a2, b2, c2, d2, e2, f2, g2	F	10	15	78.5	176.6

Further, seven kinds of pattern masks are used in the exposure process so as to differently form the projection density. Therefore, each of the seven sheets of the color filter substrates has a different projection density by using each of the different pattern masks. A relationship between the color filter substrates 11 and the projection density is shown in table 2.

Table 2

Substrate No.	Material of	Projection	Projection	Projection
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	projection	density A (the number/mm <sup>2</sup> )	density B (sum of upper surface areas /unit surface area)	density C (sum of lower surface areas /unit surface area)
a1	E	4.8	0.000377	0.001662
b1	E	7.2	0.000565	0.002492
c1	E	9.6	0.000754	0.003323
d1	E	14.4	0.001130	0.004985
e1	E	19.2	0.001507	0.006647
f1	E	28.8	0.002260	0.009970
g1	E	43.2	0.003393	0.014958
a2	F	4.8	0.000377	0.000848
b2	F	7.2	0.000565	0.001271
c2	F	9.6	0.000754	0.001695
d2	F	14.4	0.001130	0.002543
e2	F	19.2	0.001507	0.003391
f2	F	28.8	0.002260	0.005086
g2	F	443.2	0.003393	0.007632

On the rest of seven sheets of color filter substrates a2, b2, c2, d2, e2, f2, g2, other acryl-based resistor (as a material F of the projection) is coated by the spin coater so that a coated film has a thickness of 4.7μm. The coated substrates are pre-baked, exposed through a mask having a desired pattern to ultraviolet rays, developed and then post-baked, thereby forming the projection 52.

At this time, if the projection formed of the material F is compared with that formed of the material E, the projection formed of the material F has the same shape, i.e., the circular cone shape of which a peak portion is cut away, as shown in FIG. 2a, and the same definition and value of the upper surface area. However, the projection formed of the material F has a different value of

the lower surface area. Each of the upper and lower surface areas is shown in Table 1.

Further, like the material E, other seven kinds of pattern masks are used in the exposure process so as to differently form the projection density.

5 Therefore, each of the seven sheets of the color filter substrates has a different projection density by using each of the different pattern masks. A relationship between the color filter substrates 11 and the projection density is also shown in table 2.

In the table 2, there are shown the total number of projections with  
10 respect to the surface area of a region (indicated region) that the liquid crystal material is contacted with the substrate, i.e., the number of projections per the surface area of  $1\text{mm}^2$  (projection density A), and the sum of the upper surface areas per unit surface area of the indicated region, i.e., the ratio of the sum of the upper surface areas of the projections and the  
15 surface area of the indicated region (projection density B), and the ratio of the sum of the lower surface areas of the projections and the surface area of the indicated region (projection density C). In the ratio of the sum of the upper surface areas of the projections and the surface area of the indicated region (projection density B), for example, in case of the color filter substrate



a1, since the projections which respectively have an upper surface area of  $78.5\mu\text{m}^2$  are formed in a density of  $4.8 \text{ EA} / 1\text{mm}^2$  and  $1\mu\text{m}^2$  is  $1 \times 10^{-6}\text{mm}^2$ , the upper surface area can be calculated as follows:  $78.5 \times 4.8 \times 10^{-6} = 0.0003768$ .

Then, the fourteen sheets of color filter substrates a1 to g1 and a2 to g2 and prepared fourteen sheets of opposite substrates 12 are treated by, in turn, a substrate cleaning process, an alignment layer printing process, a hardening process of the alignment layer, a rubbing process in a desired direction, and then another cleaning process after the rubbing process. At this time, the alignment layer is formed of a polyimide-based material and has a thickness of  $50 \sim 80\text{nm}$ .

A seal printing process is performed on the color filter substrate 11, and a conductive paint is coated on the opposite substrate 12. At this time, the seal material contains glass fibers of 2.0 %, having a diameter of  $5.2\mu\text{m}$ .

Then, the fourteen sets of color filter substrates 11 and the opposite substrates 12 are bonded. After the seal material is hardened, desired processes such a glass cutting process, a liquid crystal injecting process, a sealing process, etc., are performed. Therefore, as shown in FIG. 1, fourteen sheets of liquid crystal panels 10 (hereinafter, respectively called as "a1 to g1, a2 to g2" are fabricated.

With respect to the fabricated fourteen sheets of liquid crystal panels 10, first, an examination of the bubble generation at a low temperature is performed.

After exposing all of the fourteen sheets of liquid crystal panels 10 to a low temperature of -30°C for 6 hours, it is investigated whether bubbles are generated. Further, on the panel in which the bubbles are not generated, an iron ball 9 of 10g is dropped down from a height of 30cm. Then, it is also investigated whether the bubbles are generated. The results thereof are shown in table 3.

10 Table 3

Panel No.	Bubble generation state	Gap non-uniformity generation state		
		1kgf/cm <sup>2</sup>	3kgf/cm <sup>2</sup>	5kgf/cm <sup>2</sup>
a1	O	O	Δ	X
b1	O	O	O	X
c1	O	O	O	Δ
d1	O	O	O	O
e1	Δ	O	O	O
f1	X	O	O	O
g1	X	O	O	O
a2	O	Δ	X	X
b2	O	O	X	X
c2	O	O	Δ	X
d2	O	O	O	X
e2	Δ	O	O	Δ
f2	X	O	O	O
g2	X	O	O	O

In the table 3, a symbol X indicates a bubble generation state after the panel

is exposed to the low temperature,  $\Delta$  indicates a bubble generation state after the an impact is applied to the panel by the iron ball 9, and O is a state that the bubbles are not generated in both cases.

According to the bubble generation state shown in table 3, it appears  
5 that the more the projection density is increased, the more the bubble generation state is deteriorated. However, regardless the difference between the materials E and F, if the ratio of the sum of the upper surface areas of the projections and the surface area of the indicated region (projection density B) is 0.0015 or more, it is easy to generate the bubbles.

10 That is, the bubble generation state is determined by the ratio of the sum of the upper surface areas and the surface area of the indicated region.

Continuously, with respect to the liquid crystal panels 10, an examination of panel strength is performed. As shown in FIG. 7, in a status that a spring balance 8 is interposed between the two liquid crystal panels,  
15 three different loads, i.e., 98kPa (1kgf/cm<sup>2</sup>), 294kPa (3kgf/cm<sup>2</sup>), 490kPa (5kgf/cm<sup>2</sup>) are respectively applied to the liquid crystal panels. Then, a change state of cell gap is visually observed. Like the bubble generation state, the result is shown in table 3.

Furthermore, in the table 3, the symbols O,  $\Delta$  and X indicate cell gap

non-uniformity state of a portion of the liquid crystal panels, in which each of the different loads is applied. The symbol O shows the cell gap non-uniformity of 0.04  $\mu\text{m}$  and less, the symbol  $\Delta$  shows the cell gap non-uniformity of 0.04  $\mu\text{m}$  through 0.08  $\mu\text{m}$  and the symbol X the cell gap non-uniformity of 0.08  $\mu\text{m}$  or more.

According to the cell gap non-uniformity state shown in table 3, it appears that the more the projection density is decreased, the more the cell gap non-uniformity state is deteriorated. However, regardless the difference between the materials E and F, it is easy to occur the cell gap non-uniformity corresponding to the ratio of the sum of the lower surface areas of the projections and the surface area of the indicated region (projection density C).

Meanwhile, since it is not general status that the load applied to the liquid crystal panel during or after the panel assembly process is 294kPa (3kgf/cm<sup>2</sup>) or more, it can assume that the liquid crystal panel having a level of symbol  $\Delta$  under the load of 294kPa (3kgf/cm<sup>2</sup>) is excellent. On the basis of this fact, if the ratio of the sum of the lower surface areas of the projections and the surface area of the indicated region (projection density C) is 0.0016 or more, as for the panel strength matter, the panel can be regarded as an

excellent product.

**(Second embodiment)**

In the sencond embodiment, the same examination as that in the first embodiment was performed with other color filter substates for an IPS-liquid  
5 crystal panel, in which the transparent electrode was not formed.

First, fourteen sheets of color filter substrates for a 13.3-inch XGA or IPS-liquid crystal panel were prepared for the examination. As shown in FIG. 4, these color filter substates are for the IPS-liquid crystal panel, and the transparent electrode is not formed on a surface of the color filter substrate.

10 Like in the first embodiment, on each of seven sheets a3, b3, c3, d3, e3, f3, g3 out of the fourteen sheets of color filter substrates 11, acryl-based resistor (as a material E of the projection) is coated by a spin coater so that a coated film has a thickness of 4.7 $\mu$ m. And on the rest of seven sheets of color filter substrates a4, b4, c4, d4, e4, f4, g4, other acryl-based resistor (as a  
15 material F of the projection) is also coated by the spin coater so that a coated film has a thickness of 4.7 $\mu$ m. The coated substrates are pre-baked, exposed through a mask having a desired pattern to ultraviolet rays, developed and then post-baked, thereby forming the projection 52.

At this time, except a fact that a height of the projction is lowered, the

projection 52 has a circular cone shape of which a peak portion is cut away, as shown in FIG. 2a. Further, as for the lower surface area of the projection, it is the same as that in the first embodiment as shown in table 4.

**Table 4**

Substrate No.	Material of projection	Diameter of upper surface ( $\mu\text{m}$ )	Diameter of lower surface ( $\mu\text{m}$ )	Upper surface ( $\mu\text{m}^2$ )	Lower surface ( $\mu\text{m}^2$ )
a3, b3, c3, d3, e3, f3, g3	E	10	21	78.5	346.2
a4, b4, c4, d4, e4, f4, g4	F	10	15	78.5	176.6

- 5 Further, as for the projection density, each of the panels is also fabricated, like in the first embodiment, using the seven different pattern masks, as shown in table 5.

**Table 5**

Substrate No.	Material of projection	Projection density A (the number/ $\text{mm}^2$ )	Projection density B (sum of upper surface areas /unit surface area)	Projection density C (sum of lower surface areas /unit surface area)
a3	E	4.8	0.000377	0.001662
b3	E	7.2	0.000565	0.002492
c3	E	9.6	0.000754	0.003323
d3	E	14.4	0.001130	0.004985
e3	E	19.2	0.001507	0.006647
f3	E	28.8	0.002260	0.009970
g3	E	43.2	0.003393	0.014958
a4	F	4.8	0.000377	0.000848
b4	F	7.2	0.000565	0.001271
c4	F	9.6	0.000754	0.001695

<b>d4</b>	<b>F</b>	<b>14.4</b>	<b>0.001130</b>	<b>0.002543</b>
<b>e4</b>	<b>F</b>	<b>19.2</b>	<b>0.001507</b>	<b>0.003391</b>
<b>f4</b>	<b>F</b>	<b>28.8</b>	<b>0.002260</b>	<b>0.005086</b>
<b>g4</b>	<b>F</b>	<b>443.2</b>	<b>0.003393</b>	<b>0.007632</b>

Then, the fourteen sheets of color filter substrates a3 to g3 and a4 to g4 and prepared fourteen sheets of opposite substrates 12 are treated by, in turn, a substrate cleaning process, an alignment layer printing process, a hardening process of the alignment layer, a rubbing process in a desired direction, and then another cleaning process after the rubbing process. At this time, the alignment layer is formed of a polyimide-based material and has a thickness of 50 ~ 80nm.

A seal printing process is performed on the color filter substrate 11, and a conductive paint is coated on the opposite substrate 12. At this time, the seal material contains glass fibers of 2.0 %, having a diameter of 5.2  $\mu\text{m}$ .

Then, the fourteen sets of color filter substrates 11 and the opposite substrates 12 are bonded. After the seal material is hardened, desired processes such a glass cutting process, a liquid crystal injecting process, a sealing process, etc., are performed. Therefore, fourteen sheets of liquid crystal panels 10 (hereinafter, respectively called as “a3 to g3, a4 to g4” are fabricated.

With respect to the fabricated fourteen sheets of liquid crystal panels

10, like in the first embodiment, examinations of the bubble generation at a low temperature and the panel strength are performed. The results are shown in table 6.

Table 6

Panel No.	Bubble generation state	Gap non-uniformity generation state		
		1kgf/cm <sup>2</sup>	3kgf/cm <sup>2</sup>	5kgf/cm <sup>2</sup>
a3	O	Δ	X	X
b3	O	Δ	X	X
c3	O	O	X	X
d3	O	O	Δ	X
e3	O	O	O	X
f3	O	O	O	O
g3	X	O	O	O
a4	O	X	X	X
b4	O	Δ	X	X
c4	O	Δ	X	X
d4	O	Δ	X	X
e4	O	O	X	X
f4	O	O	O	X
g4	X	O	O	Δ

- 5 According to the bubble generation state shown in table 6, like in the first embodiment, it appears that the more the projection density is increased, the more the bubble generation state is deteriorated. However, regardless the difference between the materials E and F, the bubble generation state is determined by the ratio of the sum of the upper surface areas and the surface
- 10 area of the indicated region.

In case of the color filter substrate in which the transparent electrode



is not formed, if the ratio of the sum of the upper surface areas of the projections and the surface area of the indicated region (projection density B) is 0.003 or more, it is easy to generate the bubbles.

Moreover, according to the cell gap non-uniformity state, like in the  
5 first embodiment, it appears that the more the projection density is decreased, the more the cell gap non-uniformity state is deteriorated. However, regardless the difference between the materials E and F, it is easy to occur the cell gap non-uniformity corresponding to the ratio of the sum of the lower surface areas of the projections and the surface area of the  
10 indicated region (projection density C).

In case of the color filter substrate in which the transparent electrode is not formed, if the ratio of the sum of the lower surface areas of the projections and the surface area of the indicated region (projection density C) is 0.005 or more, as for the panel strength matter, the panel can be regarded  
15 as an excellent product.

It seems that the difference between the preferable values of the projection density, in accordance with whether the transparent electrode is existed or not, is caused by a fact that a strength of the transparent electrode is high. Therefore, it appears that the stuck depth (plastic deformation amount

and elastic deformation amount) of the projection formed on the transparent electrode is decreased.

**[Effect of the Invention]**

According to the liquid crystal panel of the present invention, it is  
5 possible to restrict the bubble generation and also to obtain a sufficient strength of the panel. Further, according to the method of manufacturing the liquid crystal panel of the present invention, the bubble generation is prevented, and the liquid crystal panel having the sufficient strength can be stably manufactured.

**[Description of Drawings]**

**FIG. 1 is a schematic view of a liquid crystal panel fabricated by a manufacturing method according to an embodiment of the present invention.**

**5           FIG. 2 is a schematic view of a projection.**

**FIG. 3 is a schematic view of a color filter substrate in which the projection is formed on a transparent electrode.**

**FIG. 4 is a schematic view of a color filter substrate in which the transparent electrode is not formed.**

**10           FIG. 5 is a schematic view of a liquid crystal panel in which a cell gap is maintained by scattered beads.**

**FIG. 6 is a view of an example of an examination for investigating whether the bubble is generated by an impact.**

**15           FIG. 7 is a view of an example of an examination for measuring a panel strength.**

**[Meaning of numerical symbols in the drawings]**

	<b>3 : alignment layer</b>	<b>4 : transparent electrode</b>
	<b>6 : array wire</b>	<b>7 : liquid crystal layer</b>
	<b>8 : spring balance</b>	<b>9 : iron ball</b>
	<b>10 : liquid crystal panel</b>	<b>11 : color filter substrate</b>
<b>5</b>	<b>12 : opposite substrate</b>	<b>21 : black matrix (light</b>
	<b>shielding layer)</b>	
	<b>22 : color filter layer</b>	<b>51 : bead</b>
	<b>52 : projection</b>	<b>53 : upper surface of the</b>
	<b>projection</b>	
<b>10</b>	<b>54 : lower surface of the projection</b>	
	<b>55 : section for defining the upper surface of the projection</b>	

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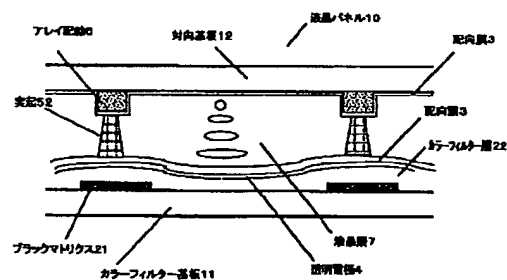
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(54) 【発明の名称】 液晶パネルおよびその製造方法

(57) 【要約】

【課題】 基板上に形成した突起によってセルギャップを支持する液晶パネルでは、突起の大きさ、形状、突起の下地の構成によって、低温気泡の発生しやすさやパネルの押圧に対する強度が異なり、最適な突起密度をもとめることが困難である。

【解決手段】 突起の密度を、突起のカラーフィルター基板と接する面積の総和の表示領域面積に対する比と、突起上底の対向基板と接する面積の総和の表示領域面積に対する比とによって管理することが効果的である。



【特許請求の範囲】

【請求項1】カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.0016倍以上である液晶パネル。

【請求項2】カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.0015倍以下である液晶パネル。

【請求項3】カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.0016倍以上であり、かつ前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.0015倍以下である液晶パネル。

【請求項4】表面に透明電極を有さないカラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.005倍以上である液晶パネル。

【請求項5】表面に透明電極を有さないカラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.003倍以下である液晶パネル。

【請求項6】表面に透明電極を有さないカラーフィルタ

ー基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.005倍以上であり、かつ前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.003倍以下である液晶パネル。

【請求項7】一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し、前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記複数の突起の前記一方の基板と接する面積の総和と前記一方の基板の前記液晶材料と接する領域の面積との比が所定の値以上となるよう、前記突起の形成密度を設定する液晶パネルの製造方法。

【請求項8】一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し、前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記突起の形成されていない他方の基板と接する前記突起の面積の総和と前記他方の基板の前記液晶材料と接する領域の面積との比が所定の値以下となるよう、前記突起の形成密度を設定する液晶パネルの製造方法。

【請求項9】一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記突起の前記一方の基板と接する面積の総和と前記一方の基板の前記液晶材料と接する領域の面積との比が所定の値以上となるよう、前記突起の密度を設定し、かつ、前記突起の形成されていない他方の基板と接する前記突起の面積の総和と前記他方の基板の前記液晶材料と接する領域の面積との比が所定の値以下となるよう、前記突起の形成密度を設定する液晶パネルの製造方法。

【請求項10】複数の突起が形成される一対の基板のいずれか一方の基板がカラーフィルター基板である請求項7～9のいずれかに記載の液晶パネルの製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はセルギャップを支持するために突起を用いた液晶パネルおよび液晶パネルの製造方法に関する。

【0002】

【従来技術】従来の技術について、図5を用いて説明

する。

【0003】液晶パネルは2枚の基板を貼り合せて組み立てられているが、カラーフィルター基板11および対向基板12間のギャップを均一に保持するために、スペーサーを設置することが必要である。

【0004】従来、スペーサーとしてジビニールベンゼン系やベンゾグアナミン系の樹脂製球状ビーズ51、又は酸化珪素系の無機球状ビーズ51をカラーフィルター基板11と対向基板12のいずれか一方に散布した後、2枚の基板の貼り合せを行っていた。

【0005】上記ビーズ散布方式は、その簡便性により、現在生産されている大多数の液晶パネルの組立てに適用されている。

【0006】しかしながら、近年、液晶パネルに対する表示品位向上の要求にともない、以下の点の改善が要求されている。すなわち、(1)散布されたビーズ51及びその周辺からの光ぬけや、散布時のビーズ凝集による光ぬけに起因する表示の不均一性やコントラストの低下、(2)更なるセルギャップ均一性の向上、(3)液晶パネルに振動を与えた時のビーズ粒子51の移動に起因するセルギャップ均一性の低下、または配向膜3表面への傷、等である。

【0007】これらの問題点を解決すべく、近年、予めカラーフィルター基板上にフォトリソグラフィー等の手法を用いて、一定間隔に、均一高さとなるように形成された樹脂製の突起をセルギャップ保持のためのスペーサーとし、散布ビーズを省略する構成(ビーズレス構成)が検討され、一部の商品では、すでに採用されている。

【0008】

【発明が解決しようとする課題】しかしながら、上記のカラーフィルター基板上に形成された樹脂製の突起52の場合、一般的に樹脂製ビーズ51と比較して塑性変形量が大きく、また弾性変形量が小さいため、その設置密度の設計マージンが狭いという課題があった。

【0009】突起の設置密度が大きすぎる液晶パネルでは、-30℃程度の低温に放置した場合、液晶材料の熱収縮にパネルの弾性変形が追従できずに真空気泡が発生してしまう、低温気泡の発生という課題がある。

【0010】一方、突起の設置密度が小さすぎる液晶パネルでは、突起が、下地となるカラーフィルター層や遮光層等の樹脂層にめり込みやすくなってしまい、生産プロセスにおける不均一な加圧や、パネル使用時に突発的に加えられる荷重(押圧)によってギャップムラが発生してしまう、パネル強度の低下という課題がある。

【0011】図2(a)、(b)に示すように、突起52は円錐または多角錐の頂点部分を切取った形状をしており、この上底53の面積と下底54の面積やそれらの比は、突起形成に用いる樹脂材料やその時々設計事情によって様々であるが、突起の面積や形状、下地となる樹脂層の構成によっても、上述の低温気泡やパネル強度

低下の発生のし易さは異なる。従来、突起密度の設計は突起の個数により決定されていたが、このように突起密度を設計することは、十分に有効な管理方法とはなっていないかった。

【0012】本発明の目的は、低温気泡の発生が抑制可能な突起密度の設計の際の有効な管理方法を得ること、及び生産プロセスにおける不均一な加圧や、液晶パネル使用時に突発的に加えられる荷重(押圧)によるギャップムラの発生を抑制可能な突起密度の設計の際の有効な管理方法を得ることである。

【0013】

【課題を解決するための手段】上記課題を解決するために、本発明の液晶パネルの製造方法では、突起のカラーフィルター基板と接する面積、及び対向基板と接する面積によって管理する。

【0014】低温気泡に関しては、低温におけるパネルとしての弾性変形量の低下が原因であるので、主としてパネルを支える突起の上底面積の管理が重要である。一方、パネル強度の低下に関しては、突起のカラーフィルター層へのめり込みが原因であるので、突起のカラーフィルター基板と接する面の面積(カラーフィルター基板上に突起を作成した場合には下底面積)の管理が重要となる。

【0015】すなわち、カラーフィルター基板上に形成された突起が液晶パネルの表示領域(基板と液晶材料とが接する領域)内でほぼ均一に配置されているとすると、低温気泡に対しては、個々の突起の形状、上底面積、下底面積にかかわらず、パネル表示領域内の突起上底面積の総和とパネル表示領域面積に対する比を低温気泡の発生を抑制できる所定の値以下となるよう突起密度を管理することが効果的であり、またパネル強度低下に対しては、個々の突起の形状、上底面積、下底面積にかかわらず、パネル表示領域内の突起下底面積の総和とパネル表示領域面積に対する比をパネル強度の低下を抑制できる所定の値以上となるよう突起密度を管理することが効果的である。

【0016】例えば、パネル表示領域面積を $S$ 、個々の突起の上底面積、下底面積をそれぞれ $s_{上底}$ 、 $s_{下底}$ とし、その形成密度を $D$ (個数/表示領域面積)と定義する。突起上底面積の総和( $=S_1$ とする)とパネル表示領域面積 $S$ との比が $\alpha$ 以下の範囲において低温気泡の発生が抑制可能であり、突起下底面積の総和( $=S_2$ とする)とパネル表示領域面積 $S$ との比が $\beta$ 以上の範囲においてパネル強度の低下が抑制可能であるとすると、 $S_1/S \leq \alpha$ 、 $S_2/S \geq \beta$ とするためには、 $S_1$ 、 $S_2$ はそれぞれ、 $S_1 = D \times S \times s_{上底}$ 、 $S_2 = D \times S \times s_{下底}$ であるから、突起形成密度 $D$ を、 $\beta/s_{下底} \leq D \leq \alpha/s_{上底}$ の範囲に設定すればよい。

【0017】なお、突起をカラーフィルター基板に対向する対向基板に形成する場合には、低温気泡の発生、お

よびパネル強度の低下の双方が、カラーフィルター基板に接する面積（この場合には、突起上底面積）に依存するため、突起形成密度 $D$ を、 $\beta/s$ 上底 $\leq D \leq \alpha/s$ 上底の範囲に設定すればよい。

【0018】また、本発明の液晶パネルでは、表示領域面積と突起のカラーフィルター基板と接する面積、および対向基板に接する面積との比を、所定の範囲としており、低温気泡の発生、パネル強度の低下が抑制できる。

【0019】この面積比の値は、カラーフィルター基板11の突起と接する領域の層構成によって異なり、図3に示すように表面に透明電極4を形成したカラーフィルター基板11上に設置された突起の場合は、突起のカラーフィルター基板11と接する面積の総和が、パネル表示領域面積に対して0.0016倍以上であり、また、対向基板12と接する面積が、パネル表示領域面積に対して0.0015倍以下であることが好ましい。

【0020】また、図4に示すような、横電界方式により駆動されるIPSモードに用いるような、表面に透明電極4が存在しないカラーフィルター基板11上に設置された突起の場合は、突起のカラーフィルター基板11と接する面積の総和が、表示領域面積に対して0.005以上であり、また、対向基板と接する面積が、0.003以下であることが好ましい。

【0021】

【発明の実施の形態】請求項1記載の液晶パネルは、カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.0016倍以上である液晶パネルである。

【0022】請求項2記載の液晶パネルは、カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.0015倍以下である液晶パネルである。

【0023】請求項3記載の液晶パネルは、カラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板が透明電極およびこの透明電極上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.

0016倍以上であり、かつ前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.0015倍以下である液晶パネルである。

【0024】請求項4記載の液晶パネルは、表面に透明電極を有さないカラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.005倍以上である液晶パネル、である。

【0025】請求項5記載の液晶パネルは、表面に透明電極を有さないカラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.003倍以下である液晶パネル、である。

【0026】請求項6記載の液晶パネルは、表面に透明電極を有さないカラーフィルター基板と前記カラーフィルター基板に対向する対向基板との間に液晶材料を挟持し、前記カラーフィルター基板上に形成された前記両基板間のギャップを一定に保持するための複数の突起を備えた液晶パネルであって、前記突起の前記カラーフィルター基板と接する面の面積の総和が、前記カラーフィルター基板の前記液晶材料と接する領域の面積の0.005倍以上であり、かつ前記突起の前記対向基板と接する面の面積の総和が、前記対向基板の前記液晶材料と接する領域の面積の0.003倍以下である液晶パネル、である。

【0027】請求項7記載の液晶パネルの製造方法は、一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し、前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記複数の突起の前記一方の基板と接する面積の総和と前記一方の基板の前記液晶材料と接する領域の面積との比が所定の値以上となるよう、前記突起の形成密度を設定する液晶パネルの製造方法、である。

【0028】請求項8記載の液晶パネルの製造方法は、一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し、前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記突起の形成されていない他



方の基板と接する前記突起の面積の総和と前記他方の基板の前記液晶材料と接する領域の面積との比が所定の値以下となるよう、前記突起の形成密度を設定する液晶パネルの製造方法、である。

【0029】請求項9記載の液晶パネルの製造方法は、一対の基板のいずれか一方の基板上に、前記一対の基板間のギャップを一定に保持するための複数の突起を形成し前記一対の基板を前記複数の突起を介して貼り合わせ、前記一対の基板間に液晶材料を挟持させる液晶パネルの製造方法であって、前記突起の前記一方の基板と接する面積の総和と前記一方の基板の前記液晶材料と接する領域の面積との比が所定の値以上となるよう、前記突起の密度を設定し、かつ、前記突起の形成されていない他方の基板と接する前記突起の面積の総和と前記他方の基板の前記液晶材料と接する領域の面積との比が所定の値以下となるよう、前記突起の形成密度を設定する液晶パネルの製造方法、である。

【0030】請求項10記載の液晶パネルの製造方法は、複数の突起が形成される一対の基板のいずれか一方の基板がカラーフィルター基板である液晶パネルの製造方法、である。

【0031】以下、発明の実施の形態について図面を用いて詳細に説明する。

【0032】(実施の形態1) 13.3インチXGA用のTFT液晶パネルの組み立てを通じて、突起52の密度に対する、低温気泡とパネル強度の関係を調べた。

【0033】まず、13.3インチXGATN型液晶パネル用のカラーフィルター基板を14シート準備した。このカラーフィルター基板は、図3に示すように表面に透明電極が形成されている。

【0034】上記14シートのカラーフィルター基板11のうちの7シート(それぞれ、基板a1、b1、c1、d1、e1、f1、g1とする)に、スピンコーターによってアクリル系のレジスト(突起材料A)を、膜厚が4.7 $\mu$ mとなるように塗布し、プリベーク、所定パターンのマスクを介しての紫外線露光、現像、ポストベークの工程を経て突起52を形成した。

【0035】このときの突起52の形状は、図2(a)に示すように円錐の頂点部分を切取った形状をしており、その上底53、下底54の面積を(表1)に示す。なお、上底53の面積は、パネル作成後に突起52が塑性変形と弾性変形を起こすことを考慮して、突起高さの90%の高さ部分の断面積55で定義した。

【0036】

【表1】

基板番号	突起材料	上底直径 ( $\mu$ m)	下底直径 ( $\mu$ m)	上底面積 ( $\mu$ m <sup>2</sup> )	下底面積 ( $\mu$ m <sup>2</sup> )
a1, b1, c1, d1, e1, f1, g1	A	10	21	78.5	346.2
a2, b2, c2, d2, e2, f2, g2	B	10	15	78.5	176.6

また、紫外線露光に用いたマスクには、突起52の密度が異なる7通りのパターンのマスクを用い、7枚のカラーフィルター基板にはそれぞれ別々のマスクを用いることによって、密度が異なるように突起52を形成した。

カラーフィルター基板11と突起密度の関係を(表2)に示す。

【0037】

【表2】

基板番号	突起材料	突起密度A (個/mm <sup>2</sup> )	突起密度B (単位面積当たりの 上底面積総和)	突起密度C (単位面積当たりの 下底面積総和)
a 1	ア	4. 8	0. 000377	0. 001662
b 1	ア	7. 2	0. 000565	0. 002492
c 1	ア	9. 6	0. 000754	0. 003323
d 1	ア	14. 4	0. 001130	0. 004985
e 1	ア	19. 2	0. 001507	0. 006647
f 1	ア	28. 8	0. 002260	0. 009970
g 1	ア	43. 2	0. 003393	0. 014958
a 2	イ	4. 8	0. 000377	0. 000848
b 2	イ	7. 2	0. 000565	0. 001271
c 2	イ	9. 6	0. 000754	0. 001695
d 2	イ	14. 4	0. 001130	0. 002543
e 2	イ	19. 2	0. 001507	0. 003391
f 2	イ	28. 8	0. 002260	0. 005086
g 2	イ	43. 2	0. 003393	0. 007632

残りの7枚のカラーフィルター基板（それぞれ、基板a 2、b 2、c 2、d 2、e 2、f 2、g 2とする）には、基板a 1～g 1とは異なるアクリル系のレジスト（突起材料イ）をスピンコーターによって、その膜厚が4. 7  $\mu\text{m}$ となるように塗布し、プリベーク、所定パターンのマスクを介しての紫外線露光、現像、ポストベークの工程を経て突起5 2を形成した。

【0038】このときの突起材料イによって作成した突起は、突起材料アによって作成した突起と比較すると、図2（a）に示すような円錐の頂点部分を切取った形状をしていることと、上底面積の定義およびその値に関しては同様であるが、下底の面積は異ならせた。上底5 3、下底5 4の面積を、基板a 1～g 1と同様、（表1）に示す。

【0039】また、突起材料アのとときと同様、紫外線露光に用いたマスクには、突起5 2の密度の異なる7通りのパターンを用い、7枚のカラーフィルター基板には、それぞれ密度が異なるように突起5 2を形成した。カラーフィルター基板と突起密度の関係を、基板a 1～g 1と同様、（表2）に示す。

【0040】（表2）には、突起密度として、基板と液晶材料とが接する領域（表示領域）の面積に対する総突起個数、すなわち表示領域面積1  $\text{mm}^2$ 当たりの突起個数（突起密度A）と、突起の表示領域単位面積当たりの上底面積の総和、すなわち、突起の上底面積の総和の表示領域面積に対する比（突起密度B）と、突起の下底面積の総和の表示領域面積に対する比（突起密度C）を示した。上記突起の上底面積の総和の表示領域面積に対する比（突起密度B）とは、例えばカラーフィルター基板a 1の場合、上底面積が78. 5  $\mu\text{m}^2$ の突起が、1  $\text{m}^2$ 当たりで4. 8個の密度で形成されているので、1

$\mu\text{m}^2$ は $1 \times 10^{-6} \text{mm}^2$ であるから、 $78. 5 \times 4. 8 \times 10^{-6} = 0. 0003768$ 、というように計算する。

【0041】次にこれら14枚のカラーフィルター基板1 1（a 1～g 1、a 2～g 2）と、予め別途準備しておいた14枚の対向基板1 2に、所定の基板洗浄、配向膜印刷、配向膜硬化を施し、更に、所定の方向のラビング処理、ラビング後洗浄を実施した。この際、配向膜はポリイミド系材料のものを使用し、その膜厚は50～80 nmであった。

【0042】次に、カラーフィルター基板1 1にシール印刷を、また対向基板1 2には導電ペイント塗布を施した。この時、シール材料中には繊維径5. 2  $\mu\text{m}$ のガラスファイバーを2. 0%混入した。

【0043】これら14組のカラーフィルター基板1 1と対向基板1 2とを貼り合せた後に、シール硬化後、ガラス切断、液晶7の真空注入、封口の所定の工程を実施して、図1に示す様な14枚の液晶パネル1 0（それぞれ、パネルa 1～g 1、a 2～g 2とする）を作成した。

【0044】作成したこれら14枚の液晶パネル1 0について、まず低温気泡の発生に関して試験を行なった。

【0045】これらすべての14枚の液晶パネル1 0を-30℃の恒温層に6時間放置した後に取り出し、気泡の発生の有無を調べた。更に、気泡の発生していなかったパネルに関しては、図6に示すように、30 cmの高さから10 gの鋼球9を落下させて、衝撃を加えることによる気泡の発生の有無を調査した。結果を（表3）に示す。

【0046】

【表3】

パネル番号	低温気泡発生状況	対荷重ギャップムラ発生状況		
		1 kgf/cm <sup>2</sup>	3 kgf/cm <sup>2</sup>	5 kgf/cm <sup>2</sup>
a 1	○	○	△	×
b 1	○	○	○	×
c 1	○	○	○	△
d 1	○	○	○	○
e 1	△	○	○	○
f 1	×	○	○	○
g 1	×	○	○	○
a 2	○	△	×	×
b 2	○	○	×	×
c 2	○	○	△	×
d 2	○	○	○	×
e 2	△	○	○	△
f 2	×	○	○	○
g 2	×	○	○	○

(表3)の評価では低温取り出し後、既に気泡が発生していた場合には×と、更に衝撃を加えた場合に気泡が発生した場合には△と、いずれも気泡が発生しなかった場合には○とした。

【0047】(表3)の評価結果は、低温気泡の発生状況は突起52の密度が増すほど悪化するが、突起材料ア、イの違いにかかわらず、突起52の上底面積の総和の表示領域面積に対する比(突起密度B)が0.0015を超えると、低温気泡が発生しやすくなることを示している。

【0048】すなわち、低温気泡の発生は、主としてパネルを支持していると考えられる上底面積の総和と表示領域の面積の比によって決定されている。

【0049】次にこれら液晶パネル10について、パネル強度の試験を実施した。図7に示すようにバネばかり8を介して液晶パネル10に10秒間、98kPa(1kgf/cm<sup>2</sup>)、294kPa(3kgf/cm<sup>2</sup>)、490kPa(5kgf/cm<sup>2</sup>)の3種類の荷重を加え、荷重に対する荷重を加えた前後でのセルギャップの変化を目視観察によって調べた。その結果は、低温気泡の発生状況の結果と同様、(表3)に示す。

【0050】なお、(表3)では目視の感応検査によって、荷重(押圧)を加えた場所のセルギャップムラの発生状況を○、△、×で示した。これらのギャップムラに関しては、ギャップ測定を実施して○はギャップムラが0.04μm以下、△は、ギャップムラが0.04μm以上、0.08μm以下、×は0.08μm以上であることが判明した。

【0051】(表3)ではギャップムラの発生状況は、突起52の密度が減るほど悪化するが、突起材料ア、イの違いにかかわらず、突起の下底面積の総和の表示領域

面積に対する比(突起密度C)に対応してギャップムラが発生しやすくなることを示している。

【0052】また、パネル組立て工程、あるいは組立て後に液晶パネルに負荷される荷重は294kPa(3kgf/cm<sup>2</sup>)を超えることは通常考えられないため、ギャップムラが294kPa(3kgf/cm<sup>2</sup>)の荷重をかけても△レベルよりも良好なパネルは、通常の使用に耐えうると考えられる。このことから、突起の下底面積の総和の、表示領域面積に対する比(突起密度C)が0.0016以上のパネルはパネル強度に関しては問題ないと考え得る。

【0053】(実施の形態2)本実施の形態2において、IPS用等の表面に透明電極を形成しないカラーフィルター基板を用いた場合について、同様の実験を行なった。

【0054】まず、13.3インチXGA、IPS型液晶パネル用のカラーフィルター基板を14シート準備した。図4に示すように、このカラーフィルター基板はIPS用であり、その表面に透明電極は形成されていない。

【0055】上記14シートのカラーフィルター基板11に、実施の形態1と同様に、7シート(それぞれ基板a3、b3、c3、d3、e3、f3、g3とする)に、アクリル系のレジスト(突起材料ア)を、残りの7シート(それぞれ基板a4、b4、c4、d4、e4、f4、g4とする)に、基板a3～g3に用いたものとは異なるアクリル系のレジスト(突起材料イ)を、それぞれスピンコーターによって、その膜厚が3.7μmとなるように塗布した。次に、プリベーク、所定パターンマスクを介しての紫外線露光、現像、ポストベークの工程を経て突起52を形成した。

【0056】このときの突起は、高さが低くなっている以外は、（実施の形態1）と同様、図2（a）に示すような円錐の頂点部分を切取った形状である。また、その上底53、下底54の面積に関しても（表4）に示すよ

うに（実施の形態1）と同様である。

【0057】

【表4】

基板番号	突起材料	上底直径 ( $\mu\text{m}$ )	下底直径 ( $\mu\text{m}$ )	上底面積 ( $\mu\text{m}^2$ )	下底面積 ( $\mu\text{m}^2$ )
a3, b3, c3, d3, e3, f3, g3	ア	10	21	78.5	346.2
a4, b4, c4, d4, e4, f4, g4	イ	10	15	78.5	176.6

また、突起密度に関しても（実施の形態1）と同様に、（表5）に示すように7通りのものを作成した。

【0058】

【表5】

基板番号	突起材料	突起密度A (個/ $\text{mm}^2$ )	突起密度B (単位面積当たりの 上底面積総和)	突起密度C (単位面積当たりの 下底面積総和)
a3	ア	4.8	0.000377	0.001662
b3	ア	7.2	0.000565	0.002492
c3	ア	9.6	0.000754	0.003323
d3	ア	14.4	0.001130	0.004985
e3	ア	19.2	0.001507	0.006647
f3	ア	28.8	0.002260	0.009970
g3	ア	43.2	0.003393	0.014958
a4	イ	4.8	0.000377	0.000848
b4	イ	7.2	0.000565	0.001271
c4	イ	9.6	0.000754	0.001695
d4	イ	14.4	0.001130	0.002543
e4	イ	19.2	0.001507	0.003391
f4	イ	28.8	0.002260	0.005086
g4	イ	43.2	0.003393	0.007632

次にこれら14枚のカラーフィルター基板11（a3～g3、a4～g4）と、予め別途準備しておいた14枚の対向基板12に、所定の基板洗浄、配向膜印刷、配向膜硬化を施し、更に、所定の方向のラビング処理、ラビング後洗浄を実施した。この際、配向膜はポリイミド系材料のものを使用し、その膜厚は50～80nmであった。

【0059】次に、カラーフィルター基板11にシール印刷を、また対向基板12には導電ペイント塗布を施した。この時、シール材料中には繊維径5、2 $\mu\text{m}$ のガラスファイバーを2、0%混入した。

【0060】これらの14組のカラーフィルター基板11と対向基板12を貼り合せた後に、シール硬化後、ガラス割断、液晶7の真空注入、封口の所定の工程を実施して、14枚の液晶パネル10（それぞれ、パネルa3～g3、a4～g4とする）を作成した。

【0061】作成したこれら14枚の液晶パネル10について、低温気泡の発生と、押圧に対するパネル強度の測定を（実施の形態1）の場合と同様に行った。これらの結果を（表6）に示す。

【0062】

【表6】

パネル番号	低温気泡発生状況	対荷重ギャップムラ発生状況		
		1 kgf/cm <sup>2</sup>	3 kgf/cm <sup>2</sup>	5 kgf/cm <sup>2</sup>
a 3	○	△	×	×
b 3	○	△	×	×
c 3	○	○	×	×
d 3	○	○	△	×
e 3	○	○	○	×
f 3	○	○	○	○
g 3	×	○	○	○
a 4	○	×	×	×
b 4	○	△	×	×
c 4	○	△	×	×
d 4	○	△	×	×
e 4	○	○	×	×
f 4	○	○	○	×
g 4	×	○	○	△

(表6)では(実施の形態1)と同様、低温気泡の発生状況は、突起52の密度が増すほど悪化し、突起材料ア、イの違いにかかわらず、主としてパネルを支持していると考えられる上底面積の総和と表示領域の面積の比によって決定されていることがわかる。

【0063】透明電極の無いカラーフィルター基板を用いた場合には、突起の上底面積の総和の表示領域面積に対する比(突起密度B)が0.003を超えると、低温気泡が発生しやすくなることを判明した。

【0064】また、ギャップムラの発生状況は、(実施の形態1)と同様、突起の密度が減るほど悪化し、突起材料ア、イの違いにかかわらず、突起の下底面積の総和の表示領域面積に対する比(突起密度C)に対応してギャップムラが発生しやすくなることがわかる。

【0065】透明電極の無いカラーフィルター基板11を用いた場合には、突起の下底面積の総和の表示領域面積に対する比(突起密度C)が0.005以上のパネルはパネル強度に関しては良品と考え得る。

【0066】これらの透明電極の有無の相違による、突起密度の好ましい値の相違は、透明電極の剛性が高いために、透明電極上に形成された突起は、下地樹脂層へのめり込み(塑性変形分、弾性変形分)が少なくなるためと考えられる。

【0067】

【発明の効果】このように本発明の液晶パネルでは低温気泡の発生は抑制され、また、押圧に対するパネル強度については十分な強度が得られる。また、本発明の液晶パネルの製造方法によれば、低温気泡の発生しない、かつ押圧に対するパネルの強度が十分な液晶パネルを安定し製造することができる。

【図面の簡単な説明】

【図1】本発明の実施の形態1の製造方法によって作成された液晶パネルを示す概略図

【図2】突起の形状を示す概略図

【図3】突起を透明電極上に形成したカラーフィルター基板の概略図

【図4】突起を形成した表面に透明電極のないカラーフィルター基板の概略図

【図5】従来のビーズ散布方式により散布されたビーズによってセルギャップを保持する液晶パネルの概略図

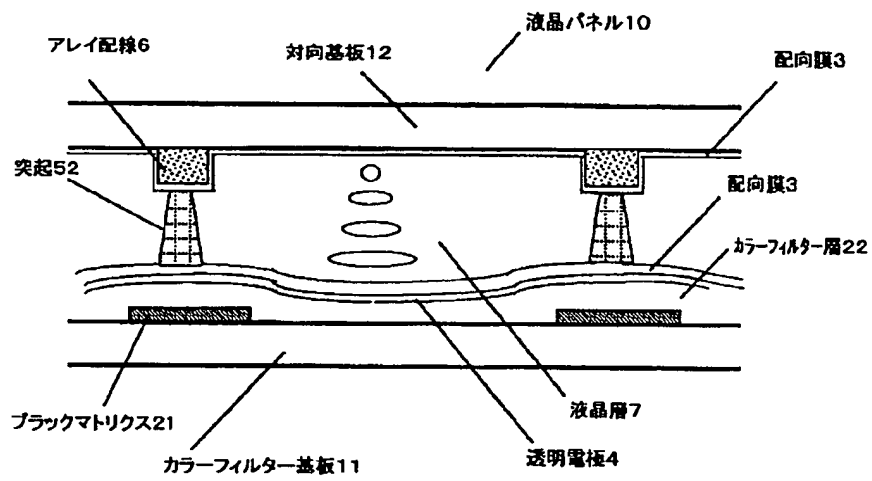
【図6】衝撃による低温気泡の発生の有無を調べる試験の1例を示す図

【図7】パネル強度を測定する試験の1例を示す図

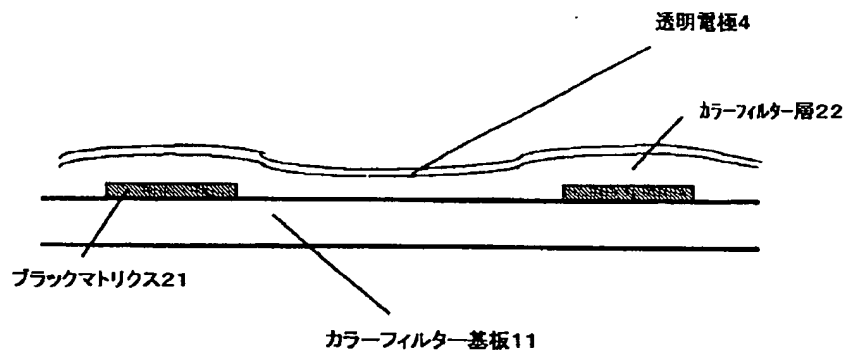
【符号の説明】

- 3 配向膜
- 4 透明電極
- 6 アレイ配線
- 7 液晶層
- 8 ばねばかり
- 9 鋼球
- 10 液晶パネル
- 11 カラーフィルター基板
- 12 対向基板
- 21 ブラックマトリクス(遮光層)
- 22 カラーフィルター層
- 51 ビーズ
- 52 突起
- 53 突起上底面
- 54 突起下底面
- 55 突起の上底面積を定義する断面

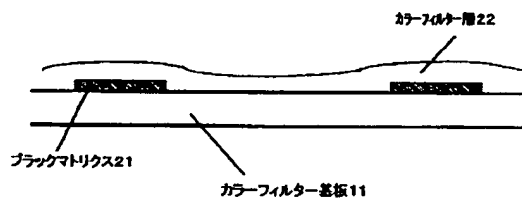
【図1】



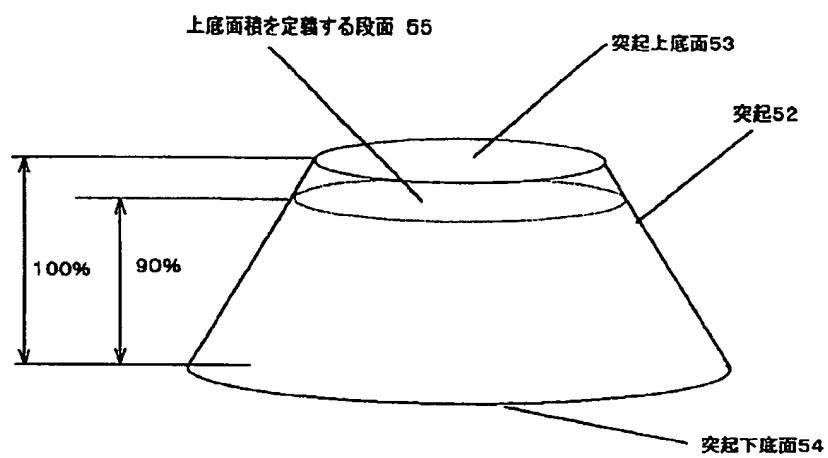
【図3】



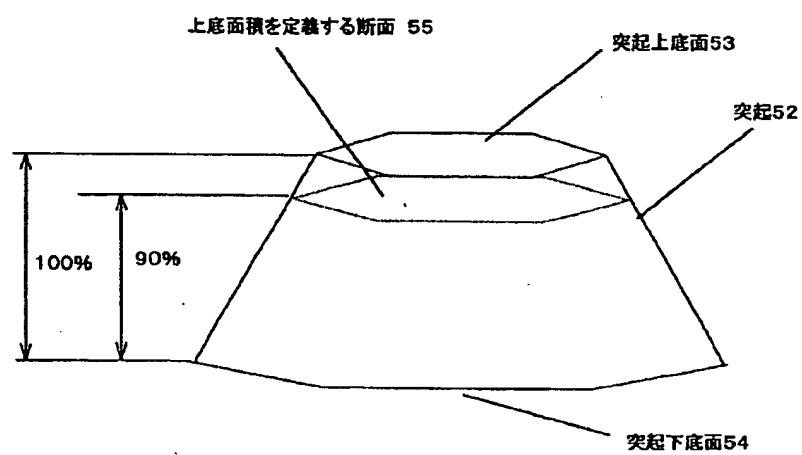
【図4】



【図2】

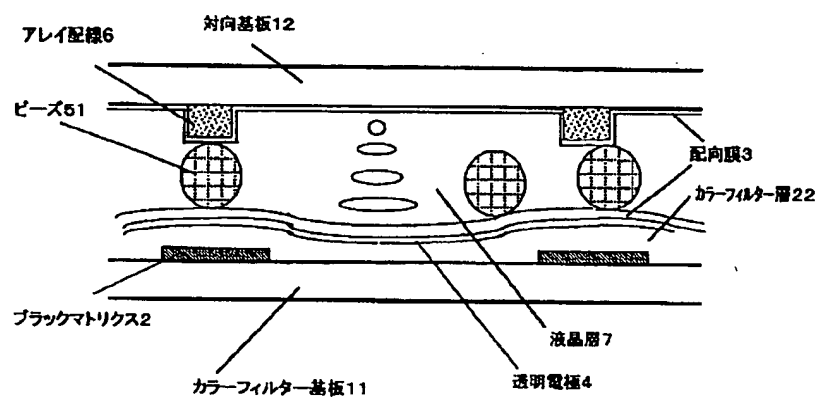


(a)

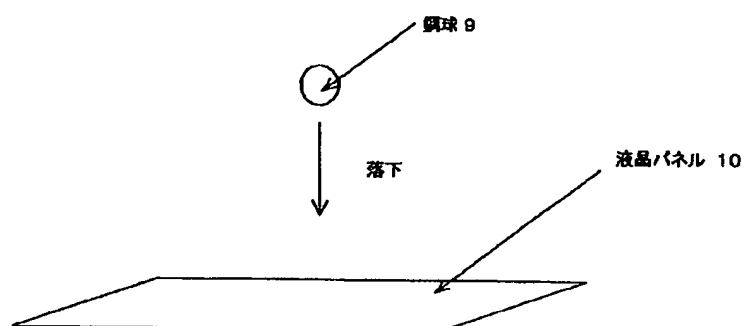


(b)

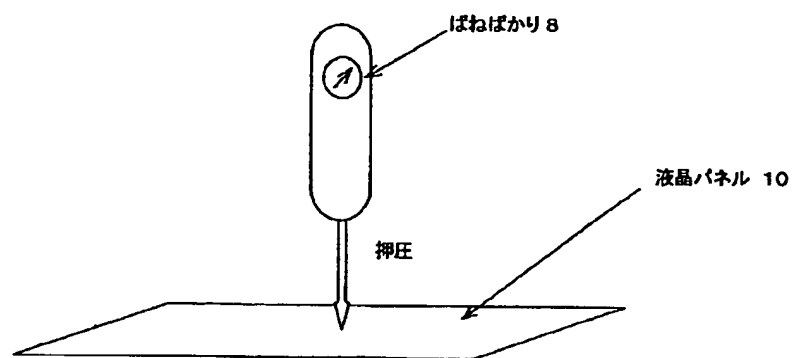
【図5】



【図6】



【図7】





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451 7th Street S.W., Washington, DC 20410  
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# Subsidized Apartment Search Results

The following properties meet your search criteria:

**City:** WASHINGTON  
**County:** DISTRICT OF COLUMBIA  
**Zip code:** 20019  
**State:** DISTRICT OF COLUMBIA  
**Type:** FAMILY

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Contact	Property	Type	Number of		
			1	2	3
EDGEWOOD MANAGEMENT CORPORATION Phone: 703-823-3380	1330 7TH STREET APARTMENTS 1330 7TH ST NW WASHINGTON, DC 20001-3565 Phone: 202-387-7558	Family	x	x	x
S-C Management Corp Phone: 202-561-8600	ATLANTIC GARDENS 4216 4TH ST SE WASHINGTON, DC 20032-3325 Phone: 202-561-8600	Family	x	x	x
S-C Management Corp Phone: 202-561-8600	ATLANTIC TERRACE 4301 THIRD ST S.E. WASHINGTON, DC 20032-3203 Phone: 202-561-8600	Family	x	x	x
Horning Brothers Phone: 202-659-0700	AZEEZE BATES 1521 F ST NE WASHINGTON, DC 20002-4547 Phone: (202) 396-2512	Family	x	x	x
KRIEGSFELD CORPORATION Phone: 202-363-9640	BARRY HOMES 1619 1ST ST NW WASHINGTON, DC 20001-1137 Phone: (202) 363-9640	Family	x	x	x
Horning Brothers Phone: 202 659-0700	BENNING COURTS 1703 BENNING RD NE WASHINGTON, DC 20002-7224 Phone: 202-396-2512	Family	x	x	x
Winn Managed Properties, LLC Phone: (202)583-0454 <a href="mailto:thenderson@winco.com">thenderson@winco.com</a>	BENNING HEIGHTS 4902 ALABAMA AVE SE WASHINGTON, DC 20019-4305 Phone: (202)583-0454	Family	x	x	x
Shelter Properties, LLC Phone: (202) 582-2100	BENNING PARK TERRACE 5113 FITCH STREET SE	Family	x	x	x



	WASHINGTON, DC 20019-5918 Phone: 202-582-2100				
EDGEWOOD MANAGEMENT CORPORATION Phone: 202-529-3150	BROOKLAND MANOR AKA BRENTWOOD VILLAGE 2400 14th Street, NE Suite 1 WASHINGTON, DC 20018-1032 Phone: 202-529-3150	Family	x	x	x
Security Management, Inc. Phone: 202-265-0917	CAPITOL MANOR 1436 W ST NW WASHINGTON, DC 20009-5870 Phone: (202)265-0917	Family	x	x	x
Clark Realty Management LLC Phone: 301-272-8100	COLUMBIA HEIGHTS VILLAGE APTS 2900 14th Street NW WASHINGTON, DC 20009-6863 Phone: 202-234-6900	Family	x	x	x
EDGEWOOD MANAGEMENT CORPORATION Phone: 202-574-4633	CONGRESS PARK I 1320 CONGRESS ST SE WASHINGTON, DC 20032-5048 Phone: (202) 574-1397	Family	x	x	x
EDGEWOOD MANAGEMENT CORPORATION Phone: 202-574-4633	CONGRESS PARK II 1313 Congress St., S.E. WASHINGTON, DC 20032-5050 Phone: (202) 574-4633	Family		x	x
EDGEWOOD MANAGEMENT CORPORATION Phone: 202-832-1648	EDGEWOOD TERRACE I 601 EDGEWOOD ST NE WASHINGTON, DC 20017-3314 Phone: 202-832-0400	Family	x	x	x
NRM ASSOCIATES, INC. Phone: (301) 652-3358	EUCLID STREET APARTMENTS 1312 EUCLID ST NW WASHINGTON, DC 20009-4848	Family	x		x
EDGEWOOD MANAGEMENT CORPORATION Phone: 703-823-3380	FAIRCLIFF PLAZA EAST 1356 Fairmont ST NW WASHINGTON, DC 20009-6976 Phone: (301) 431-1378	Family	x	x	x
EDGEWOOD MANAGEMENT CORPORATION Phone: 703-823-3380	FAIRCLIFF PLAZA WEST 1400 Euclid ST NW WASHINGTON, DC 20009-4563 Phone: 202-986-2802	Family	x	x	x
KSI MANAGEMENT CORP Phone: 703-641-9000	FAIRMONT I AND II APARTMENTS 1400 Fairmont Street NW WASHINGTON, DC 20009	Family	x	x	x
Crawford Edgewood Managers Phone: (202) 797-8767	FOSTER HOUSE 801 RHODE ISLAND AVE NW WASHINGTON, DC 20001-3194 Phone: 202-797-8767	Family	x	x	x
Horning Brothers Phone: 202-387-4339	FRANKLIN COMMONS 101 FRANKLIN ST NE WASHINGTON, DC 20002-1062 Phone: (202)387-4339	Family		x	x

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